

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE  
in its capacity as elected Office

Date of mailing (day/month/year) 28 May 2001 (28.05.01)	
International application No. PCT/GB00/03615	Applicant's or agent's file reference
International filing date (day/month/year) 21 September 2000 (21.09.00)	Priority date (day/month/year) 21 September 1999 (21.09.99)
Applicant GRINSTED, Timothy, William	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
20 April 2001 (20.04.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Olivia TEFY Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

TUNSTALL, Christopher, Stephen  
Harrison Goddard Foote  
Belgrave Hall  
Belgrave Street  
Leeds LS2 8DD  
ROYAUME-UNI

Date of mailing (day/month/year) 27 November 2001 (27.11.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference	
International application No. PCT/GB00/03615	International filing date (day/month/year) 21 September 2000 (21.09.00)

1. The following indications appeared on record concerning:	
<input type="checkbox"/> the applicant	<input type="checkbox"/> the inventor <input checked="" type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address TUNSTALL, Christopher, Stephen Harrison Goddard Foote Tower House Merrion Way Leeds LS2 8PA United Kingdom	State of Nationality
	State of Residence
	Telephone No. 44 (0) 113 290 1400
	Facsimile No. 44 (0) 113 244 2829
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:	
<input type="checkbox"/> the person	<input type="checkbox"/> the name <input checked="" type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address TUNSTALL, Christopher, Stephen Harrison Goddard Foote Belgrave Hall Belgrave Street Leeds LS2 8DD United Kingdom	State of Nationality
	State of Residence
	Telephone No. 44 (0) 113 233 0100
	Facsimile No. 44 (0) 113 233 0101
3. Further observations, if necessary:	
4. A copy of this notification has been sent to:	
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer  Maria Victoria CORTIELLO
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

From the:  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

TUNSTALL, Christopher S  
Harrison Goddard Foote  
Tower House  
Merion Way  
Leeds LS2 8PA  
GRANDE BRETAGNE

PCT

WRITTEN OPINION

(PCT Rule 66)

28. AUG. 2001 \*061694

Applicant's or agent's file reference <b>CST/71537WO</b>		Date of mailing (day/month/year) <b>23.08.2001</b>
International application No. <b>PCT/G800/03615</b>		REPLY DUE <b>within 3 month(s)</b> from the above date of mailing
International filing date (day/month/year) <b>21/09/2000</b>	Priority date (day/month/year) <b>21/09/1999</b>	
International Patent Classification (IPC) or both national classification and IPC <b>E02F5/10</b>		
Applicant <b>THE ENGINEERING BUSINESS LTD et al.</b>		



- This written opinion is the first drawn up by this International Preliminary Examining Authority.
- This opinion contains indications relating to the following items:
  - ☒ Basis of the opinion
  - ☐ Priority
  - ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - ☒ Lack of unity of invention
  - ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - ☐ Certain document cited
  - ☒ Certain defects in the international application
  - ☒ Certain observations on the international application
- The applicant is hereby invited to reply to this opinion.
 

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 65.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.  
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.  
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
- The final date by which the international preliminary examination report must be established according to Rule 69.2 is: **21/01/2002**

Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 sprmu d Fax: +49 89 2399 - 4465	Authorized officer / Examiner <b>Laurer, M</b> Formalities officer (incl. extension of time limits) <b>Heimann, C</b> Telephone No. +49 89 2399 2391	
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**WRITTEN OPINION**

International application No. PCT/GB00/03615

**I. Basis of the opinion**

1. With regard to the elements of the international application (Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"):

**Description, pages:**

1-10 as originally filed

**Claims, No.:**

1-17 as originally filed

**Drawings, No.:**

1/17-17/17 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

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☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

## IV. Lack of unity of invention

1. In response to the invitation (Form PCT/IPEA/405) to restrict or pay additional fees, the applicant has:

- ☐ restricted the claims.  
☐ paid additional fees.  
☐ paid additional fees under protest.  
☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with for the following reasons and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees:  
see separate sheet

3. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this opinion:

- ☒ all parts.  
☐ the parts relating to claims Nos. .

## V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement

Novelty (N)	Claims 16
Inventive step (IS)	Claims 1, 15, 17
Industrial applicability (IA)	Claims

2. Citations and explanations  
see separate sheet

## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

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see separate sheet

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
see separate sheet

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SEPARATE SHEET**

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**Cited documents**

- D1: US-A-4 759 138 (GRINSTED TIMOTHY W) 26 July 1988 (1988-07-26)  
D2: EP-A-0 010 915 (BRITISH PETROLEUM CO) 14 May 1980 (1980-05-14)  
cited in the application  
D3: US-A-4 802 793 (GRINSTED TIMOTHY W ET AL) 7 February 1989 (1989-02-07)  
D8: FR-A-1 107 641 (MULON) 4 January 1956 (1956-01-04)

**Re Item IV**

The diverse contributions of the current invention:

The special technical feature distinguishing independent claim 1 from the closest prior art of D1, figure 5, is constituted by the "soil engaging fins". The technical problem solved is: To enhance the steering performance of the plough through superposing alternative steering principles;

The distinguishing technical feature of independent claim 11 in relation to the closest prior art D8 figure 2, is the "guiding means at the bridle limb retention points in combination with the movable bridle limb attachment points". The technical problem solved is: Changing the distribution of the load transfer from the bridle limbs into the plough, this change has no influence on the prior art steering performance;

There is no distinguishing technical feature of independent claim 16 in relation to the closest prior art D1 figure 5. Relative to claim 11 this claim is concerned in the concept of fixed length bridle limbs with a mechanical compensation linkage for insuring complementary displacement of the bridle limb attachment points;

In the concept of variable length bridle limbs the special technical feature distinguishing independent claim 17 from the closest prior art D8 figure 2, is the "mechanical link(age) between the bridle limbs". The technical problem solved is: Achieving a simple configuration permitting the relative length of the bridle limbs to adapt actively and/or passively to changes in the towing direction;

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SEPARATE SHEET**

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The distinct groups of invention are:

1. Improving the steering performance of the plough by superimposing alternative steering principles, for claim 1 and
2. Improving the transfer of the towing load through the bridle limbs into the plough, for claim 11 and
3. Improving the bridle steering system enabling that the bridle compensates changes in the relative towing position, for claims 16 and 17;

As demonstrated in the preceding paragraphs these three groups are not so linked as to form a single general inventive concept (Rule 13.1 PCT).

**Re Item V**

- 1 In the terms of current independent claim 1 document D1, figure 8, which is considered to be the closest prior art, discloses:  
a plough comprising a plough share (10) and a tow rope attachment mechanism having a tow rope retention point (50), the tow rope attachment mechanism being adapted to enable adjustment of the position of the tow rope retention point (50) relative to the plough, thereby altering the position at which the line of a tow rope retained by the tow rope retention point crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions.
  - 1.1 The distinguishing feature of the current invention compared to D1 is "the steerable soil engaging fins".
  - 1.2 The technical effect derived from this feature is an improved tracking stability and the possibility to steer the plough independently from the alternative steering concept (= inducing a torque through the towing rope) by inducing a side force from the ground or means on the ground which causes a torque to steer the plough.
  - 1.3 Each steering concept has different advantages when steering the plough. Combination of these two steering concepts constitutes a juxtaposition, because each concept is acting independently, giving rise to its own technical performance



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SEPARATE SHEET**

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without having any combinational effect, with reference to the "PCT-Guidelines" Section IV, Chapter IV-8.3a. This formulation is consistent with the disclosure of a mechanical blocking means in independent claim 2, serving to block one steering mechanism (steering through the tow rope by moving the tow rope retention point) in order to steer the plough by the other steering concept (steerable ground engaging fins).

- 1.4 Document D2 figure 4 shows fins (34) for stabilizing the track of the plough and members (33, 30, 31, 34) for stabilizing and steering the plough (21) by swivelling the skids (30, 31) and respectively the fins (34) around a vertical axis. This steering concept generates side forces from the surface and applies them to the plough, in order to counter the varying towing loads resulting from changes in the relative towing position.
- 1.5 Both steering concepts are disclosed in the prior art and constitute a juxtaposition. Thus, the subject-matter of current independent claim 1 does not involve an inventive step required by Article 33(3) PCT.
- 2 The additional feature of dependant claim 2 "releasable mechanical locking means" for blocking the tow rope attachment mechanism is described in D3, column 2, line 53-55 and is therefore not considered to contribute to an inventive step. A person skilled in the art would select this routine constructional change, to improve the controllability of the plough by decreasing the degree of freedom for the steering systems.
- 3 The additional features of dependant claims 3-6 are shown in D1 figure 8 and are in the scope what a man skilled in the art would introduce in the invention without involving an inventive step.

**claims**

- 3: tow rope (20) attachment mechanism with a bridle having two bridle limbs (52, 54) for splitting the towing load and transferring it into the plough;
- 4: adjustment of the tow rope retention point (50), by movement of the bridle rope retention points (70, 71) for steering the plough through the towing rope;

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- 5: pivotable pair of arms (99) providing respective bridle rope attachment points (70, 71) at the outboard ends for moving the towing rope retention point;
- 6: pivotable arms (99) extending substantially laterally with respect to the plough for moving the bridle limb retention points;
- 3.1 The additional feature of claim 7 (pivotable arms extending substantially longitudinally with respect to the plough) is not known from the prior art cited in the search report, but appears to constitute no more than a routine design measure unsuited to contributing an inventive step.
- 3.2 The additional feature of dependent claim 8 (a tow rope attachment mechanism adapted to move from towing to lifting position) for lifting the plough is described in D1, column 6, lines 15 to 45, as a feature of D1, figure 8 and fails therefore to contribute to an inventive step.
- 3.3 The additional feature of dependent claim 9 in relation to the prior art D8, figure 2, is the "steerable soil engaging fins". As mentioned under paragraphs 1 to 1.5 a person skilled in the art would integrate the steerable soil engaging fins to the prior art D8, figure 2, forming a juxtaposition for an alternative steering concept, without involving an inventive step.
- 3.4 The additional feature of dependent claim 10 (bridle limb retention points as guides in combination with movable bridle limb attachment points) for improving the load transfer into the plough, is not known from the prior art, cited in the search report, but appears to constitute no more than a routine design measure unsuited to contributing an inventive step (see paragraph 4 and 4.1).
- 4 In the terms of current independent claim 11, D8 figure 2, which is considered to represent the closest prior art, discloses:  
a plough (a) comprising a plough share (b) and a tow rope attachment mechanism (k, l, m) having a pair of bridle limb retention points (h, i), the tow rope attachment mechanism being adapted to enable adjustment of the relative length of a pair of bridle limbs retained by the bridle limb retention points (h, i), thereby altering the position at which the line (p) of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of

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offset tow positions.

- 4.1 The distinguishing features of current independent claim 11 in relation to the closest prior art, are the bridle limb retention points in form of guides through which the bridle limbs pass, in combination to the movable bridle limb attachment points. The technical effect in relation to the prior art is the different load transfer of the towing loads from the bridle limbs into the plough by inducing a reduced torque into the arms (e).

These features of current claim 11 are not known from the prior art cited in the search report, but appear to relate to no more than a variety of routine design features as such they appear unsuited to contribute to an inventive step according Article 33(3) PCT. For instance starting from D8 the location of the turnbuckles (l, m) opposite the bridle limb retention points (h, l) and the associated provision of pulleys at said points (l, m) is within the range of routine design measures for a skilled person to reduce the torque induced into the arms (e) by the bridle limbs.

- 5 The additional features of dependent claims 12 and 13 ("fins (34) carried on skids (31)" and "skids (31) carried on a steering member") in relation to independent claim 1 are shown in D2, figure 3; a person skilled in the art would choose this installation in order to limit the penetration depth of the fins without involving an inventive step;

The additional feature of claim 14 and the "independently height adjustable" skids of claim 15 are described in D3, column 2, lines 22-30, for the purpose of separately adjusting the penetration depth of the plough into the soil and therefore are not considered to contribute to an inventive step.

- 6 In the terms of current independent claim 16, D1 figure 5, discloses:  
a plough (10) comprising a plough share and a tow rope attachment mechanism (72, 88) having a pair of bridle limb attachment points (70, 71), the tow rope attachment mechanism being adapted to enable movement of the bridle limb attachment points relative to the plough, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a mechanical linkage between the bridle limb attachment points (80, 84) such that movement of one bridle limb attachment point in one sense is

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accompanied by movement of the other in the other sense.

Thus, subject-matter of current claim 16 lacks the novelty required by Article 33(2) PCT.

- 7 In the terms of current independent claim 17, D8, figure 2, which is considered to represent the closest prior art, discloses:
- a plough (a) comprising a plough share (b) and a tow rope attachment mechanism having a pair of bridle limbs (l, m), the tow rope attachment mechanism being adapted to enable adjustment of the relative length of the bridle limbs (l, m), thereby altering the position at which the line of the tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions.
- 7.1 The distinguishing features of current independent claim 17 in relation to the closest prior art, is the mechanical linkage between the bridle limbs such that lengthening of one bridle limb is accompanied by shortening of the other. The technical effect in relation to the prior art is the compensation of the towing load inside of the bridle system.
- 7.2 The technical problem to be solved can be formulated as reducing the actuation forces for steering the plough.
- 7.3 Document D3, column 2, lines 36 to 52, teaches that a linkage between the bridle limbs minimises the forces required to steer the plough. For a person skilled in the art starting from D8 figure 2 wishing to minimise the required steering forces for the plough, it would be an obvious possibility to integrate the mechanical linkage of D3, figure 2 into the apparatus shown in D8 figure 2.
- In this way a skilled person would arrive at the subject-matter of independent claim 17 without involving an inventive step required by Article 33(3) PCT.

**Re Item VII**

- 1 The features of the claim/s are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

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- 2 Independent claims 1, 11, 16 and 17 are not cast in two-part form as required by Rule 6.3(b) PCT. Any amended independent claim should be drafted in the two-part form, which in the present case would be appropriate, with those features known in combination from the relevant prior art (D1 respectively D8) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

**Re Item VIII**

Because claim 12 and its dependent claims 13 to 15 refer to each preceding claim, a contradiction in the reference to independent claim 11 occurs with the "soil engaging fins", which are not mentioned in claim 11. Thus, dependant claims 12, 13, 14 and 15 are not clear in relation to independent claim 11 required by Article 6 PCT.

## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

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(71) Applicant (for all designated States except US): THE ENGINEERING BUSINESS LTD (GB/GB); Broomhaugh House, Riding Mill, Northumberland NE44 6EG (GB).

(74) Agent: TUNSTALL, Christopher, Stephen; Harrison Goddard Foot, Tower House, Merriam Way, Leeds LS2 8PA (GB).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

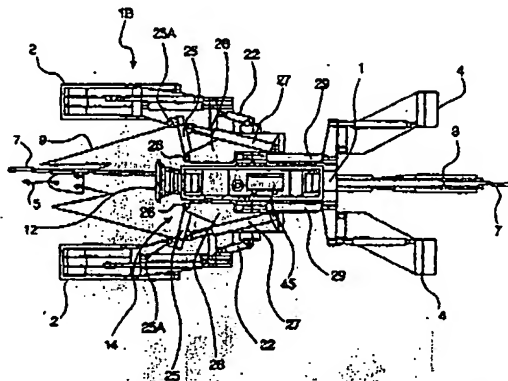
— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(72) Inventor; and

(75) Inventor/Applicant (for US only): GRINSTED, Timothy, William (GB/GB); Beaumont House, Stocksfield, Northumberland NE43 7TN (GB).

(54) Title: PLOUGHS



(57) Abstract: A marine plough (10) is described having twin, complementary steering mechanisms (13, 14): one or more steerable soil-engaging fins (21) and a tow rope (5) attachment mechanism (14) that enables adjustment of the position of a tow rope retention point relative to the plough. This alters the position at which the line of a tow rope (5) crosses the longitudinal axis of the plough, so that the plough can operate at offset tow positions. The tow rope attachment mechanism (14) comprises a bridle (9) having two bridle limbs terminating at respective bridle limb retention points. The adjustment of the position of the tow rope retention point relative to the plough is done by moving the bridle rope retention points or adjusting the relative length of the bridle limbs. The bridle limb retention points can be moved, using cylinders (29), from towing positions to lifting positions at which the tow bridle can be used to lift the plough in a substantially level attitude. The soil-engaging fins (21) are carried by supporting skids (2), in turn carried by a steering member (22; 23; 24) pivotable relative to the plough about a substantially vertical axis. Ploughing depth can be adjusted (42) by altering the vertical distance between the skids and the steering member.

WO 01/21900 A1

## INTERNATIONAL SEARCH REPORT

Intern. Appl. No.

PCT/GB 00/03615

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 E02F5/10 E02F5/14		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 E02F H02G F16L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data bases consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 759 138 A (GRINSTED TIMOTHY W) 26 July 1988 (1988-07-26)	16,17
Y	figures 5,6,8	1,3-6,8, 9,12,13
A	figures 3,4	2,11,14, 15
	figure 10 column 4, line 31 - line 57 column 5, line 47 - line 60 column 6, line 15 - line 24 column 6, line 34 - line 50	
Y	EP 0 010 915 A (BRITISH PETROLEUM CO) 14 May 1980 (1980-05-14) cited in the application figure 3 page 5, line 24 - line 27	1,3-6,8, 9,12,13
-/-		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "Z" document member of the same patent family		
Date of the actual completion of the international search 1 December 2000		Date of mailing of the international search report 14/12/2000
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016		Authorized officer Guthmuller, J

Form PCT/ISA/210 (second sheet) (July 1992)

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03615

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 802 793 A (GRINSTED TIMOTHY W ET AL) 7 February 1989 (1989-02-07)	16,17
A	figures 1,2,6-8  column 2, line 36 - line 58	1-7,9, 14,15
A	US 4 585 372 A (GRINSTEAD TIMOTHY W ET AL) 29 April 1986 (1986-04-29) figures 1,2 column 2, line 23 - line 61	1-8,9, 14-17
A	EP 0 452 021 A (NORTHERN OCEAN SERVICES LTD) 16 October 1991 (1991-10-16)	
A	DE 32 45 625 A (FOECKERSPERGER WALTER) 1 September 1983 (1983-09-01)	
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Intern. Appl. No.

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International Application No

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PLOUGHSBACKGROUND TO THE INVENTION

This invention relates to ploughs, particularly those for burial of cables and pipelines  
5 in the bed of the sea or other water.

Ploughs are well-known for use in protecting cable and pipelines underwater. The  
cables or pipelines are buried to protect them from damage by, for example, fishing  
equipment or anchors. Typically these ploughs are towed via a towrope by a vessel  
10 on the surface of the water, but may be towed by an underwater tractor. Such ploughs  
are fitted with a soil-engaging share that is shaped to dig into the seabed under the  
action of the towing force and produce a trench into which the cable or pipe is  
placed. The ploughs usually lay the cable or pipeline in the trench. The invention  
applies to all types of plough.

15 Hitherto, such ploughs have often been fitted with a steering system that operates by  
exerting transverse forces on the tow wire and thus generating couples on the plough  
that alter the direction of travel of the plough. Some of these ploughs are fitted with a  
bridle and crank mechanism to minimise the forces required to steer the plough. Such  
20 ploughs are described in patent EP 0185422. In some applications this mechanism  
can be lifted into an upright position to move the two wire attachment points to a  
position above the plough so that the same wire can lift the plough in a level attitude.

This method of steering a plough has the disadvantage that the direction of travel of  
25 the plough is affected by changes in the tow rope direction together with any side  
forces, for example from side slopes that the plough may be traversing. The plough  
or a part of it is effectively dragged sideways across the seabed.

Ploughs that steer by means of steerable fins attached to skids that support the front  
30 of the plough are also known. Such a plough is shown in EP 0010915. This design  
overcomes the disadvantage of the first design in that the plough can be steered

relative to the seabed without being dragged across the seabed. The mechanism works in the same way as the steering in a car. To minimise the steering forces required from the steerable fins on the skids, the tow rope is connected near to the back of the plough, or to a towing mechanism with a single tow point slidably  
5 mounted on a curved arm extending laterally from the main plough beam, to give the effect of towing from near the back - see EP 0010915.

This method of steering has the disadvantage that without such a force minimisation towing mechanism the steering angles relative to the tow rope are limited. Also the  
10 force minimisation towing mechanism described would be difficult to adapt for larger angles of steering because of the requirement for a mechanism of greater size.

A further feature of these ploughs is the need for the towing mechanism to pass over the top of the plough and therefore also, where applicable, the cable or pipeline  
15 passage through the plough. This prevents or limits one's ability to mount other equipment, particularly if the tow points must be transferred to a lifting position.

#### SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a plough  
20 comprising a plough share, one or more steerable soil-engaging fins and a tow rope attachment mechanism having a tow rope retention point, the tow rope attachment mechanism being adapted to enable adjustment of the position of the tow rope retention point relative to the plough, thereby altering the position at which the line of a tow rope retained by the tow rope retention point crosses the longitudinal axis of  
25 the plough, so that the plough can operate at a range of offset tow positions. The tow rope attachment mechanism may comprise releasable mechanical locking means for preventing the said adjustment from taking place.

Preferably, the tow rope attachment mechanism comprises a bridle having two bridle  
30 limbs terminating at one end at the tow rope retention point and at the other at respective bridle limb retention points. The tow rope attachment mechanism may be

adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by movement of the bridle rope retention points. For example, the tow rope attachment mechanism may include a pair of arms, each pivotable relative to the plough about a substantially vertical axis at its inboard end and providing a respective bridle rope attachment point at its outboard end. The pivotable arms may extend substantially laterally with respect to the plough or substantially longitudinally with respect to the plough.

Preferably, the tow rope attachment mechanism is adapted to enable movement of the bridle limb retention points relative to the plough from respective towing positions to respective lifting positions at which the bridle can be used to lift the plough in a substantially level attitude.

As an alternative to the above, the tow rope attachment mechanism may be adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by adjustment of the relative length of the bridle limbs. For example, the bridle limb retention points may comprise guides through which the bridle limbs pass and the plough may further comprise a pair of movable bridle limb attachment points to which the bridle limbs are attached. According to a second aspect of the present invention, there is provided a plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb retention points, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of a pair of bridle limbs retained by the bridle limb retention points, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, in which the bridle limb retention points comprise guides through which the bridle limbs pass, and further comprising a pair of movable bridle limb attachment points to which the bridle limbs are attached.

Preferably, the steerable soil-engaging fins are carried by one or more supporting skids. The supporting skids are themselves preferably carried by a steering member

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, pivotable relative to the plough about a substantially vertical axis. Means may be provided for adjusting ploughing depth by altering the vertical distance between the skids and the steering member.

- 5 Where there are two or more skids, the vertical distance between one such skid and the steering member may be alterable independently of the vertical distance between another such skid and the steering member.

- 10 A third aspect of the present invention provides a plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb attachment points, the tow rope attachment mechanism being adapted to enable movement of the bridle limb attachment points relative to the plough, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and  
15 further comprising a mechanical linkage between the bridle limb attachment points such that movement of one bridle limb attachment point in one sense is accompanied by movement of the other in the other sense.

- A fourth and related aspect of the invention provides a plough comprising a plough  
20 share and a tow rope attachment mechanism having a pair of bridle limbs, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of the bridle limbs, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a  
25 mechanical linkage between the bridle limbs such that lengthening of one bridle limb is accompanied by shortening of the other.

#### BRIEF DESCRIPTION OF THE DRAWINGS

- The present invention will now be described by way of example with reference to the  
30 accompanying drawings, in which:

Figure 1 shows in elevation a typical plough in operating position in the seabed;

Figure 2 shows a plan view of the plough of figure 1;

Figure 3 shows a plan view of the plough of figures 1 and 2 with the skids angled to steer the plough to the left;

Figure 4 shows a plan view of the plough of figures 1 and 2 with the towing mechanism moved to accommodate an offset tow position;

Figure 5 shows an elevation of the plough of figures 1 and 2 with the tow rope in lifting position;

Figures 6 and 7 show plan views of ploughs fitted with alternative methods of steering the skids;

Figures 8 and 9 show plan views of a plough fitted with an alternative method of adjusting the towing bridle in, respectively, an extended tow position and on offset tow position;

Figures 10 and 11 show elevations of the plough of figures 8 and 9 from the front of the plough with the towing bridle in an upright position; and

Figures 12-15 show plan views of alternative chassis and bridle arrangements (steerable skids and other details omitted for clarity in the case of figures 12 and 13).

Figures 16 and 17 show two passive bridle adjustment mechanisms.

#### DETAILED DESCRIPTION

Referring to the figures 1 to 5, a seabed cable plough is made up of an elongate chassis 1, a share 3 at the rear of plough 10, and support skids (2 and 4) two each at the front and rear respectively. The front skids 2 support the plough on the seabed 6 and are adjustable by hydraulic rams 42 in figures 3 and 5) to set the trenching depth of the plough. The share 3 penetrates the seabed as the plough is towed by a ship (not shown) via a towrope 5. Cable 7 to be buried enters the front of the plough at bellmouth 12 and exits underground at the back of the plough 8. Rear spaced skids 4 support the back of the plough when operating in very soft seabed soils. The plough may be fitted with a control and monitoring system and a hydraulic power pack, typically located on top of the plough at 45, allowing the operators on the ship to

operate it effectively by controlling the position of the hydraulic rams. Alternative adjustment mechanisms to rams can be used although rams are particularly suitable when the plough is used in the submarine environment.

- 5 Assemblies 28 at each side of the chassis 1 are rotatable by hydraulic rams 29 about a horizontal axis at pivot 30 and support tow adjustment mechanism 14 comprising, in this embodiment, hydraulic rams 27 sidewardly, extending pivotable arms 25 to which tow bridle 9 is attached.
- 10 In one aspect the invention uses these two mechanisms 13, 14 to control its orientation and/or motion on the seabed. The first 13 incorporates front skids 2, which are fitted with soil penetrating fins 21, either the skids and/or the fins being rotatable with respect to the plough body. Steering mechanism 13 in figures 1 and 2 is formed by hydraulic rams 22 and skids 2 which can steer the plough even when the
- 15 plough is in an offset position. The second 14 incorporates an adjustable bridle mechanism or an adjustable towing mechanism for connecting to a bridle which in turn connects to a tow member such as a tow wire. The adjustable mechanism can be arranged in one embodiment to generate a steering couple on the plough with respect to the tow wire. In another embodiment, the adjustable mechanism is arranged to
- 20 reduce steering moments imposed on the plough from the tow cable, for example, to allow offset towing. The two adjusting arrangements 13 and 14 in combination can reduce the effect changes in the tow wire direction have on the plough whilst at the same time allowing ploughing, and indeed steering while ploughing, at larger offset angles.
- 25 Spaced skids 2 each carry a ground engaging fin 21 which generate side forces to steer the plough when these are at an angle with respect to the chassis 1 as shown in figures 3, 6 and 7. More than one fin may be provided on each skid. Typically the fins extend the length of the skids. The skids are rotated with respect to the chassis by
- 30 the action of hydraulic cylinders 22 in fig 3, 23 in fig 6 and 24 in fig 7. The fins may be rotatable with respect to the chassis 1 as well or instead of the skids.



Figures 3, 6 and 7 show alternative ways of adjusting the angle of the skids to steer the plough. In figure 3, the two skids 2 with the depth adjusting linkage 42 are mounted on transverse mounting beam 41 which is itself pivotally mounted on chassis 1 at pivot 40. The adjusting linkage 42 controls the height of the plough with respect to the skids as shown in figure 5. The skids are rotated in a substantially horizontal plane with respect to the plough by the action of rams 22 extending between pivoting mounting beam 41 and a second mounting beam fixed to chassis 1. Cylinders 22 angle the beam 41 and hence the skids.

10

In figure 6 the beam 41 in figure 3 is split to form two mounting beams 44A, 44B pivotally mounted to the plough at 35. Cylinders 23 rotate each beam independently to steer the plough about pivots 35. Two positions of skids 2 are shown at 31 and 32.

15

In figure 7 the hydraulic rams or cylinders 24 rotate only the skids 2 relative to a skid mount 37 from a position 33 to a position 34 around a pivot in the region of 36. These pivots may be in the form of slots, sliders or other means of achieving rotation. Rotation of fins relative to the skids is also possible although this is less preferable because of the exposure to damage of such a mechanism as well as the adverse forces on the fins from the ground.

20

In figures 1 to 4 the tow rope 5 is connected to tow bridle 9 and this is connected to arms 25 at attachment points 25A. These arms 25 can rotate about pivots 26 about a generally vertical axis with respect to the plough under the action of hydraulic rams or cylinders 27. In figure 4 the arms 25 have been moved to accommodate the offset tow position of towrope 5. If the arms are not moved the bridle 9 would generate a steering moment on the plough because of the extra tension in one side of the bridle. The hydraulic rams move the attachment points 25A so that the centre of rotation of the bridle lies more or less above the centre of resistance of the plough ie above the landsides of the plough share 3. In this way steering moments generated by the bridle are reduced. Steering can then take place by angling the skids 2 with fins 21 to allow

30

the plough to follow the desired course on the seabed, or to allow for other side forces, for example from crossing a side slope. The arms can be moved to other positions to suit other offset tow positions on either side of the plough centreline. Of course the rams 27 can be used to generate a steering moment on the plough if  
5 required, for example when crossing a side slope, particularly when offset ploughing across a side slope.

As can be seen from figures 1, 2 and 5 the towrope adjusting mechanism 14 formed by arms 25 and cylinder 27 is mounted on assemblies 28 that are mounted pivotally  
10 on plough chassis 1. Assembly 28 can be rotated under the control of hydraulic cylinders 29. For normal operation the assembly 28 is positioned as shown in figures 1 and 2, and the plough is pulled along by the towrope 5. For lifting and lowering the plough to and from the seabed the hydraulic cylinders 29 can be operated to rotate assembly 28 about pivot 30 to the position shown in figure 5, so that the tow wire can  
15 be used to lift the plough in an approximately horizontal position.

A benefit of having two pivoted structures 28 for lifting the towrope is that the hydraulic and instrumentation package 45 can be located above the central cable route, thus lifting it higher on the machine. This helps to keep the framework and its  
20 contents out of the soil in very soft seabed conditions.

Figures 8 and 9 show bridle 9 connected via terminating chains 50 to hydraulic rams 27A. In this case rams 27A are substantially parallel to the longitudinal axis of the plough and these act to lengthen or shorten the arms of the bridle. The chains pass  
25 through guides 50, which are optionally fixed to assembly 28. When guides 50 are fixed the effective attachment points of the bridle to the plough are located at guides 50 and do not change in position. In figure 9, chain 9A has been pulled through guide 50 to shorten the left hand bridle arm, thus allowing for offset towing to the right.

Figures 10 and 11 show front views of the plough in figures 8 and 9 in which  
30 assembly 28 has been rotated through pivot 30 to allow the plough to be raised or

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lowered or manoeuvred on the seafloor, over obstacles for example. In figure 11 both arms of the bridle have been shortened since chains 9A have been retracted through, in this case, fixed guides 50.

- 5 Figure 12 shows in plan view a Y shaped plough beam with forwardly fixed arms 25 to which guides 50 are mounted. Bridle arms 9 pass through guides 50 and are lengthened or shortened under control of hydraulic rams 27B. Figure 13 shows in plan view forwardly extending pivoting arms mounted to chassis 1 and rotated under control of hydraulic rams 27C. This arrangement is less efficient in lengthening and  
10 shortening the bridle arms.

- Figures 14 and 15 show bridle 9 connected via terminating chains 50 to hydraulic rams 27A. In the case of figure 14, rams 27A are free to pivot relative to the plough and so effectively form part of the bridle arms; in figure 15, rams 27A are  
15 substantially parallel to the longitudinal axis of the plough. In these cases, the chains do not pass through guides and in the case of figure 15, this can lead to substantial and undesirable bending moments on the hydraulic rams. These arrangements are considered to be less favourable than the arrangements shown in figures 8 and 9.

- 20 Figures 16 and 17 show two passive bridle adjustment mechanisms, i.e. mechanisms in which the adjustment of the geometry of the bridle is caused by changes in the direction of tow, but is not (or need not be) caused or assisted by active or powered mechanisms on the plough. In figure 16, the bridle limbs, or extensions of them in the form of chain 62 and cable or rope 63, pass through guides 50 and around  
25 secondary guides or pulleys 61 and are connected together to form a closed loop. In figure 17, the bridle limbs 9 terminate on pivoting arms 25 that are restrained and coupled together by a rope, cable, chain or similar 60 that passes around guides or pulleys 61. The figure 17 arrangement has the advantage over the figure 16 arrangement that friction at the guides 50 is avoided. If a mechanism that is not  
30 entirely passive is desired, the pulleys 61 could for example be powered.

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Preferably, the inter-linking rope, cable or chain etc. 63 passes along the pivot axis of for the lifting drawbars. This could be achieved by using tubular pivot pins.

CLAIMS

1. A plough comprising a plough share, one or more steerable soil-engaging fins and a tow rope attachment mechanism having a tow rope retention point; the tow rope attachment mechanism being adapted to enable adjustment of the position of the tow rope retention point relative to the plough, thereby altering the position at which the line of a tow rope retained by the tow rope retention point crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions.
2. A plough according to claim 1 in which the tow rope attachment mechanism comprises releasable mechanical locking means for preventing the said adjustment from taking place.
3. A plough according to claim 1 or claim 2 in which the tow rope attachment mechanism comprises a bridle having two bridle limbs terminating at one end at the tow rope retention point and at the other at respective bridle limb retention points.
4. A plough according to claim 3 in which the tow rope attachment mechanism is adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by movement of the bridle rope retention points.
5. A plough according to claim 4 in which the tow rope attachment mechanism includes a pair of arms, each pivotable relative to the plough about a substantially vertical axis at its inboard end and providing a respective bridle rope attachment point at its outboard end.
6. A plough according to claim 5 in which the pivotable arms extend substantially laterally with respect to the plough.
7. A plough according to claim 5 in which the pivotable arms extend substantially longitudinally with respect to the plough.

- Sub A2
8. A plough according to any one of claims 3-7 in which the tow rope attachment mechanism is adapted to enable movement of the bridle limb retention points relative to the plough from respective towing positions to respective lifting positions at which the bridle can be used to lift the plough in a substantially level attitude.
9. A plough according to any one of claims 3-8 in which the tow rope attachment mechanism is adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by adjustment of the relative length of the bridle limbs.
10. A plough according to claim 9 in which the bridle limb retention points comprise guides through which the bridle limbs pass and further comprising a pair of movable bridle limb attachment points to which the bridle limbs are attached.
11. A plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb retention points, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of a pair of bridle limbs retained by the bridle limb retention points, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, in which the bridle limb retention points comprise guides through which the bridle limbs pass, and further comprising a pair of movable bridle limb attachment points to which the bridle limbs are attached.
- Sub A3
12. A plough according to any preceding claim in which the steerable soil-engaging fins are carried by one or more supporting skids.
13. A plough according to claim 12 in which the supporting skids are carried by a steering member pivotable relative to the plough about a substantially vertical axis.

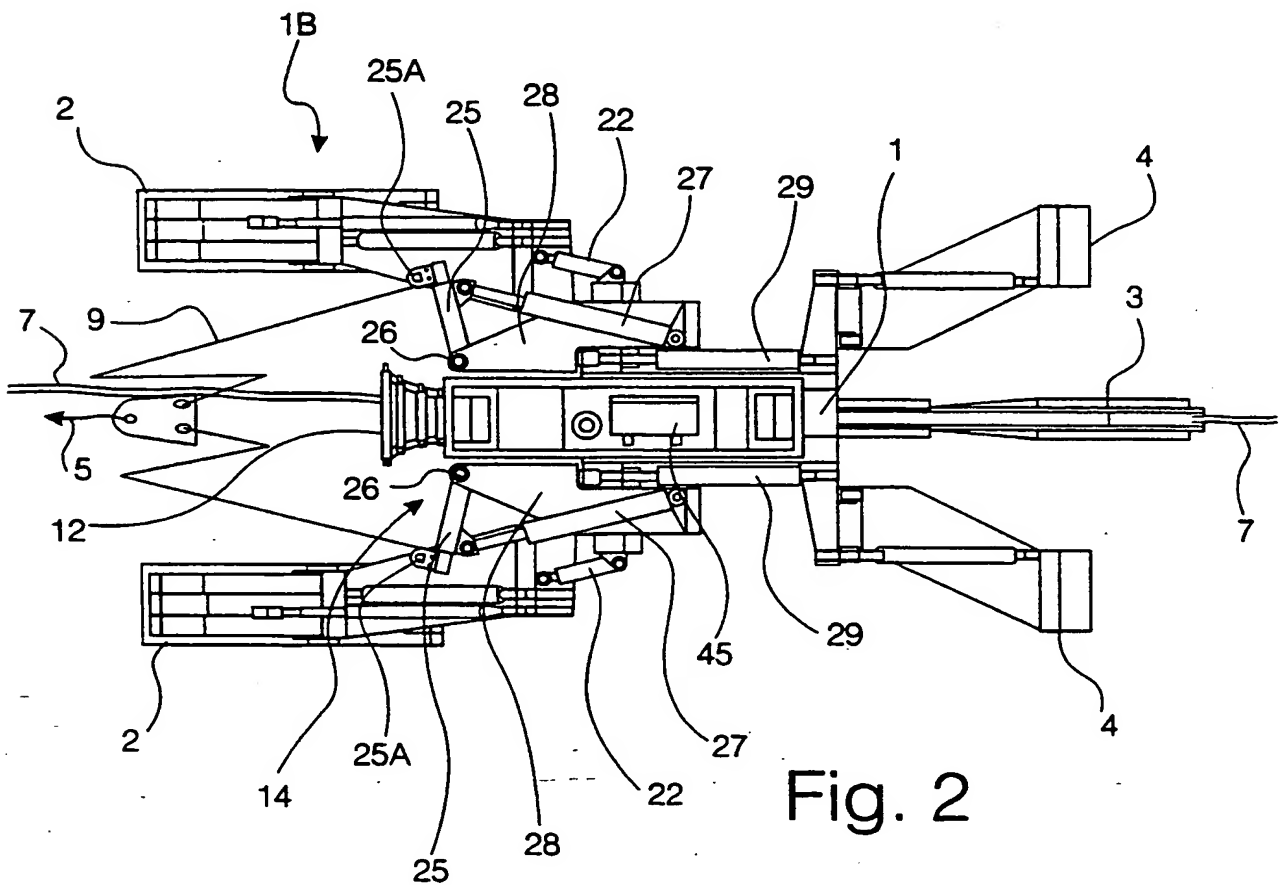
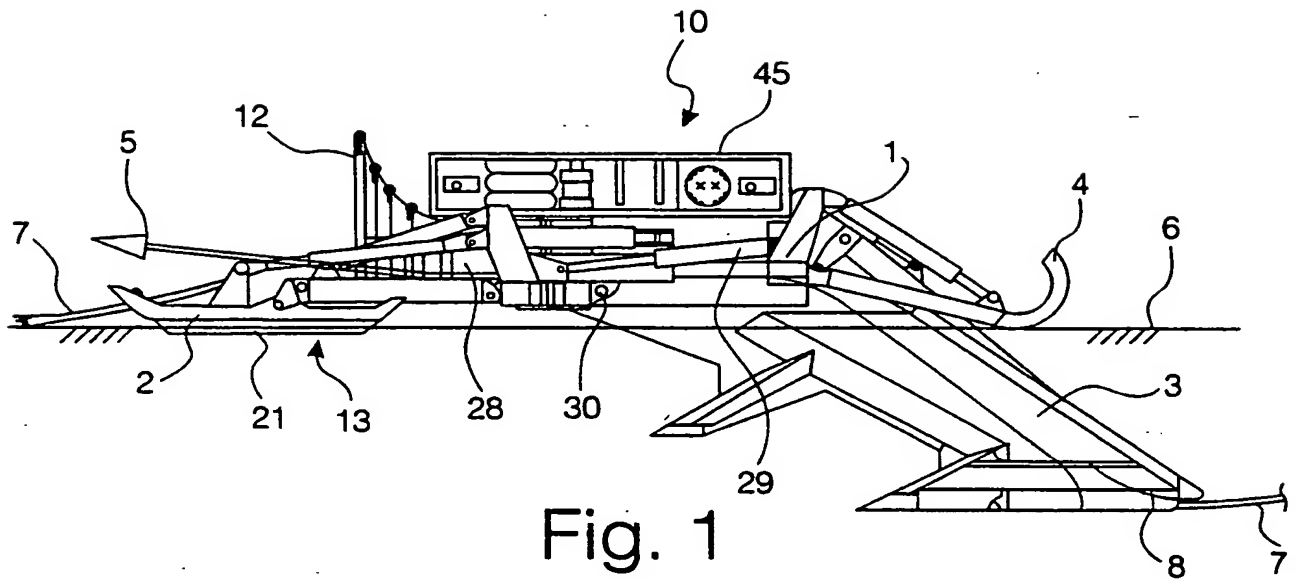
14. A plough according to claim 13 further comprising means for adjusting ploughing depth by altering the vertical distance between the skids and the steering member.

15. A plough according to claim 14 in which there are two or more skids and the vertical distance between one such skid and the steering member can be altered independent of the vertical distance between another such skid and the steering member.

16. A plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb attachment points, the tow rope attachment mechanism being adapted to enable movement of the bridle limb attachment points relative to the plough, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a mechanical linkage between the bridle limb attachment points such that movement of one bridle limb attachment point in one sense is accompanied by movement of the other in the other sense.

17. A plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limbs, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of the bridle limbs, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a mechanical linkage between the bridle limbs such that lengthening of one bridle limb is accompanied by shortening of the other.

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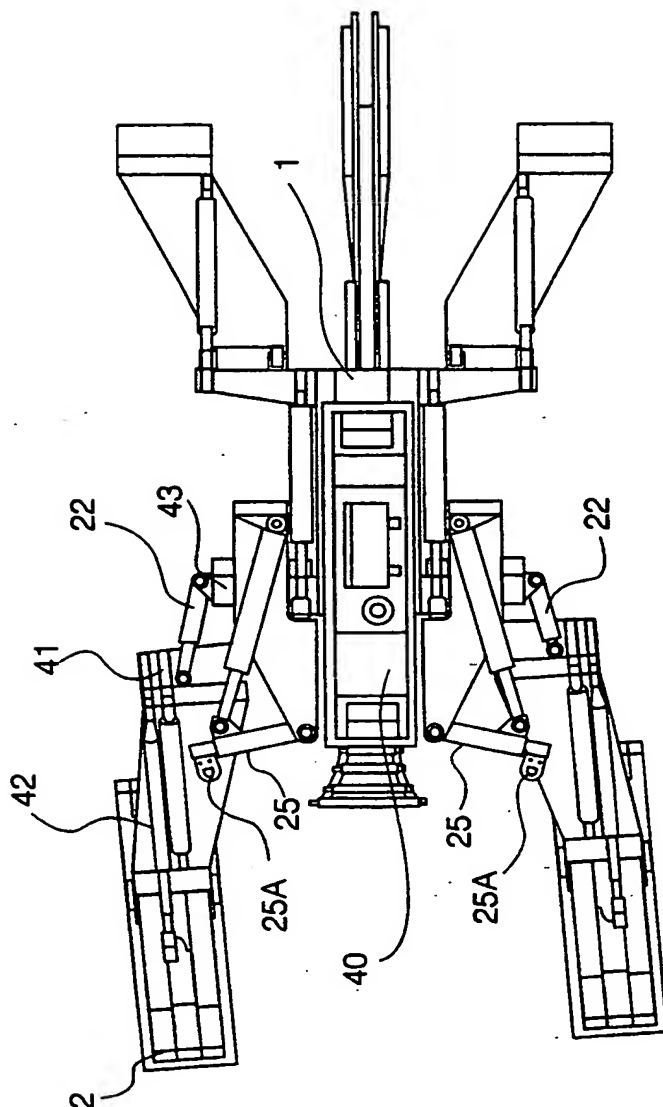


Fig. 3

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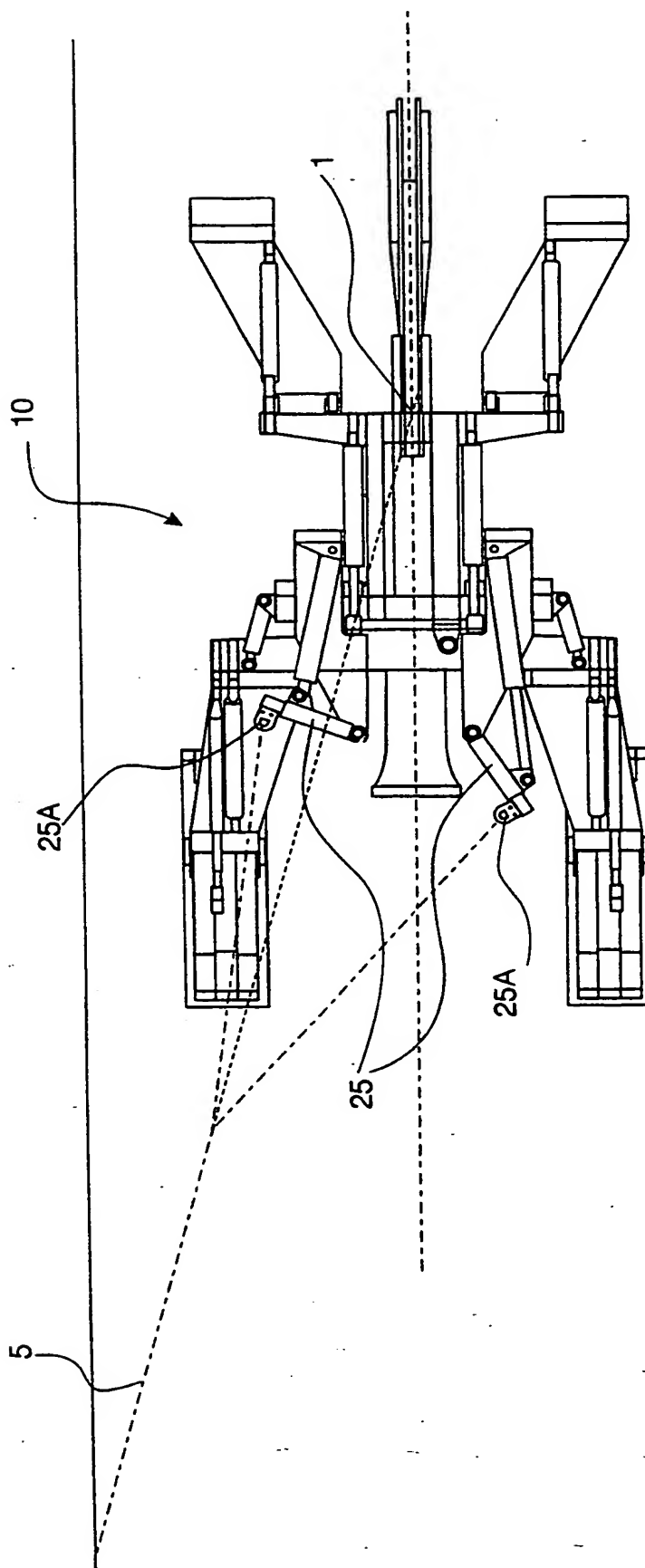


Fig. 4

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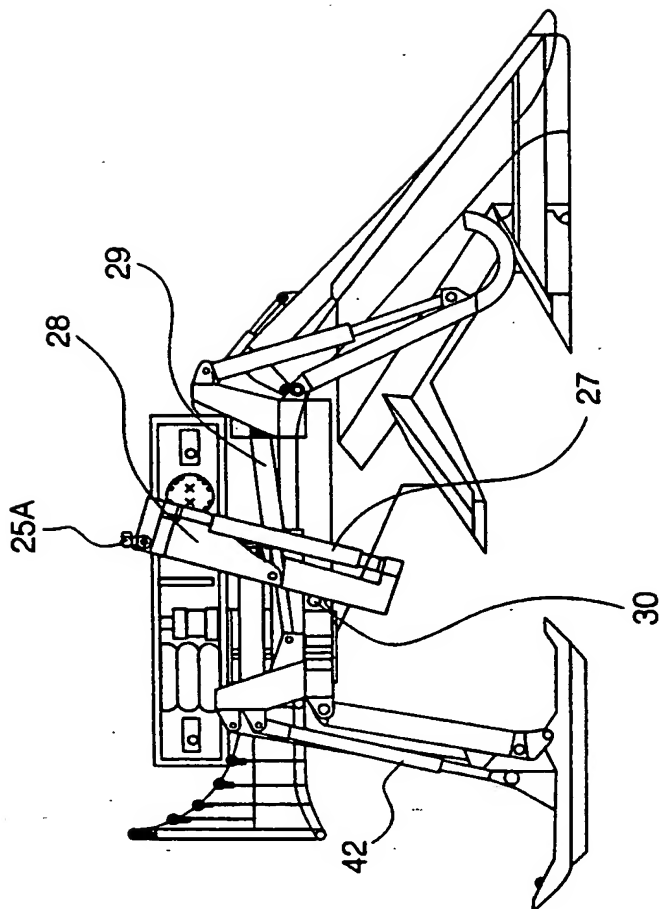


Fig. 5

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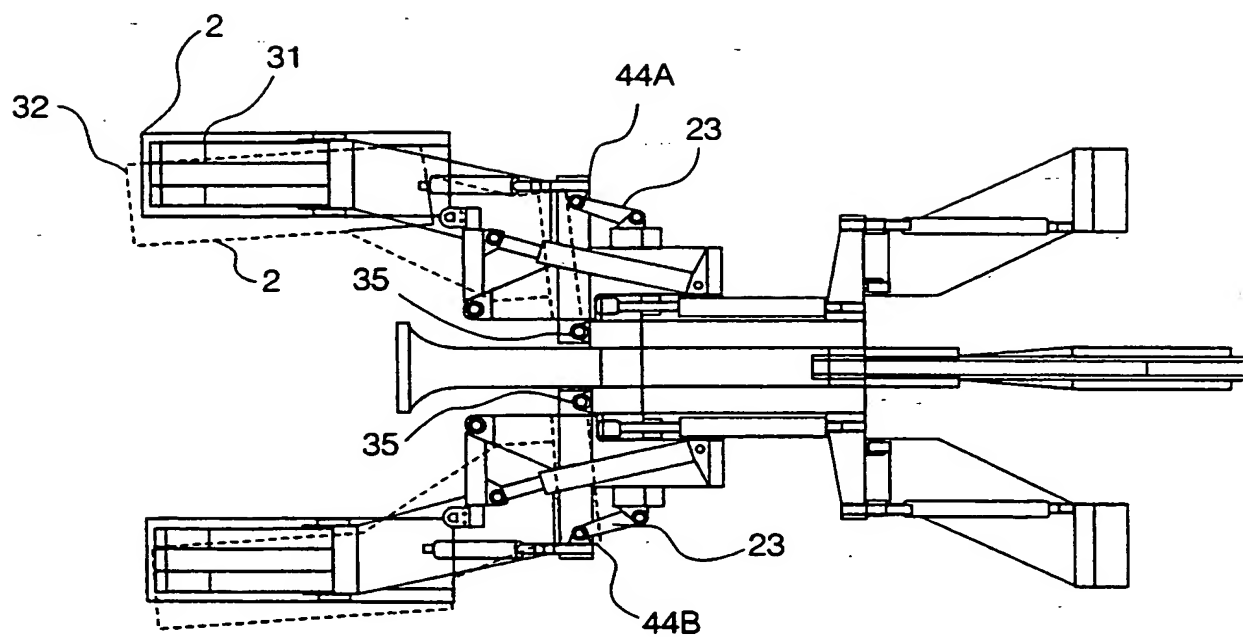


Fig. 6

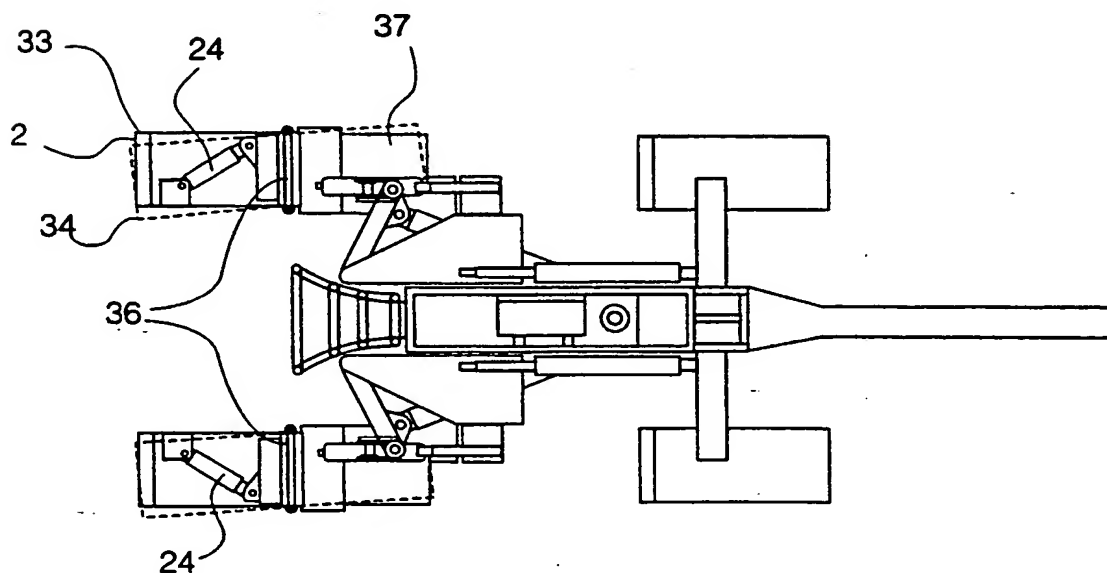


Fig. 7

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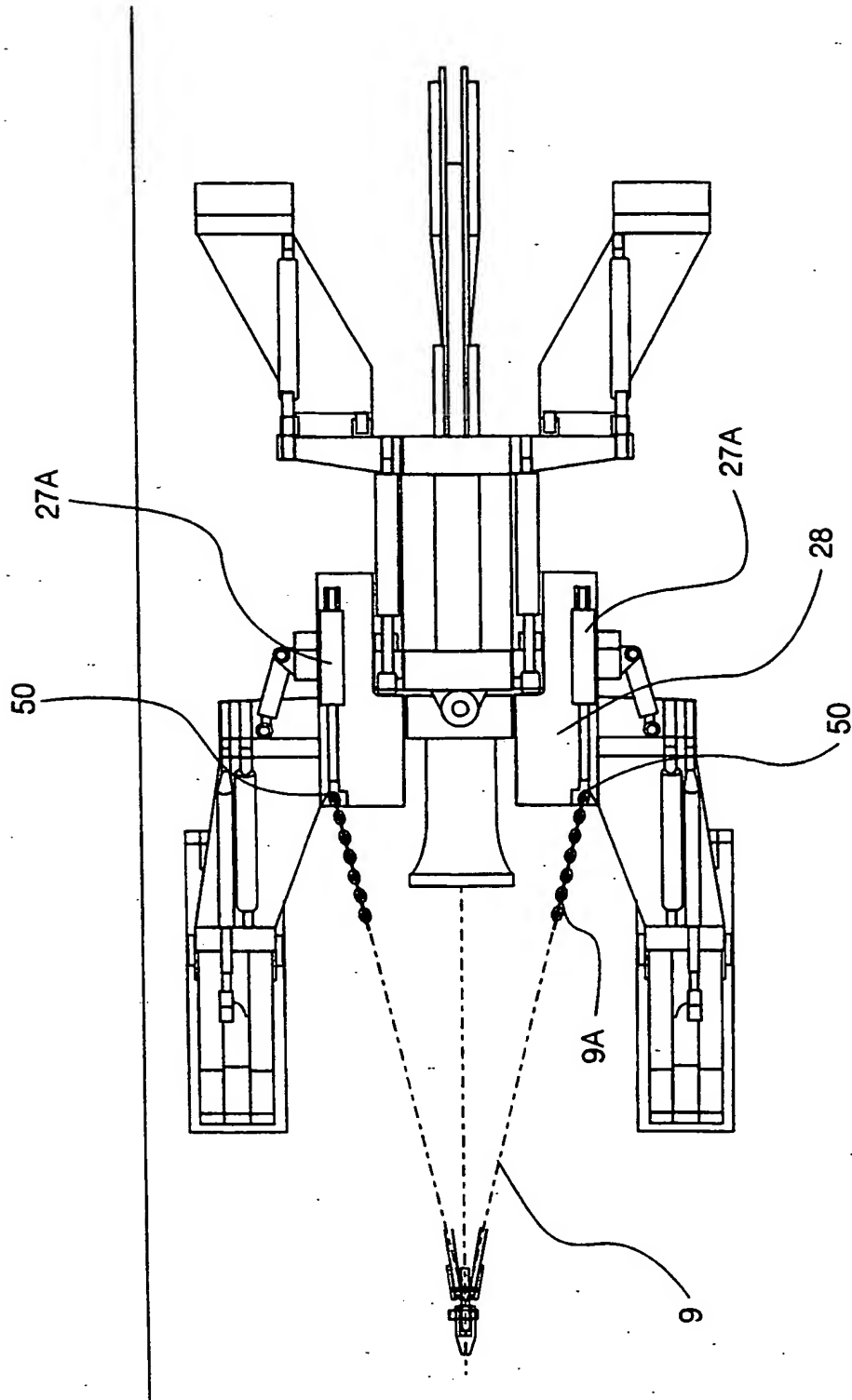


Fig. 8

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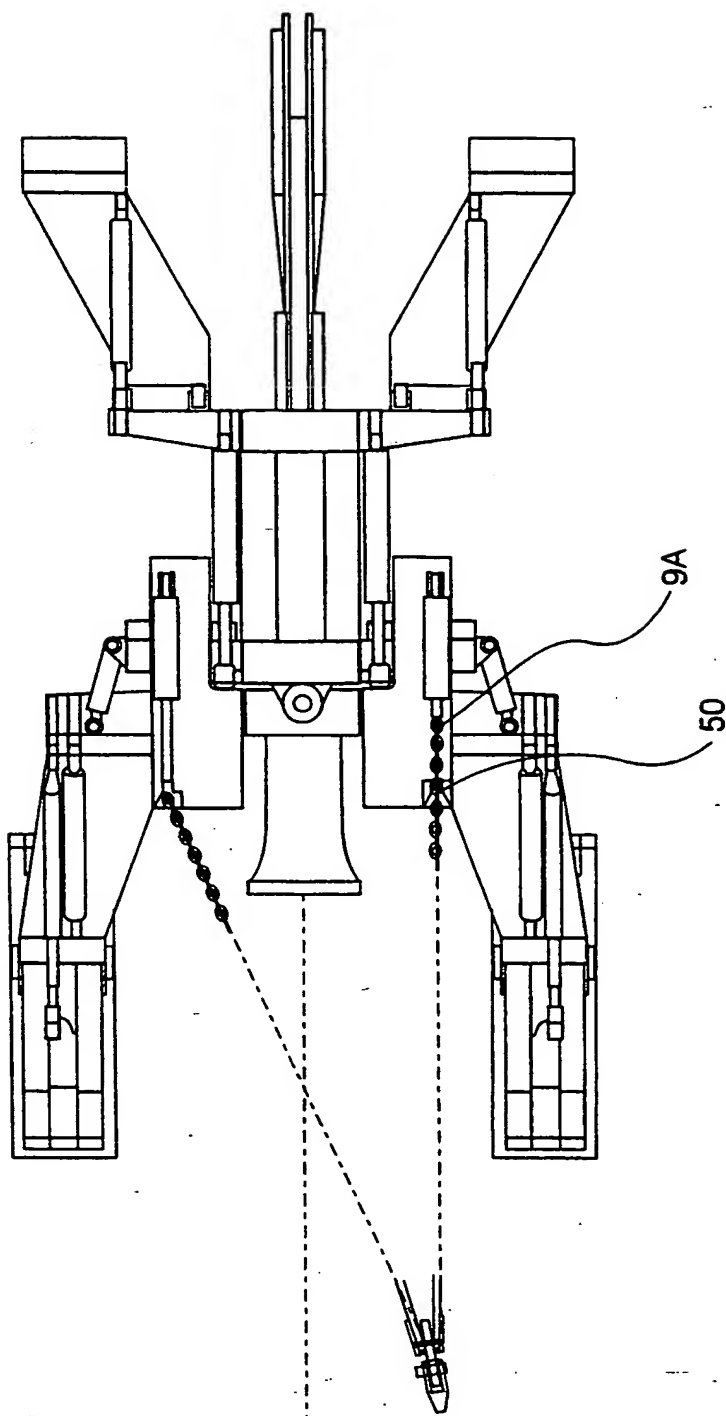


Fig. 9

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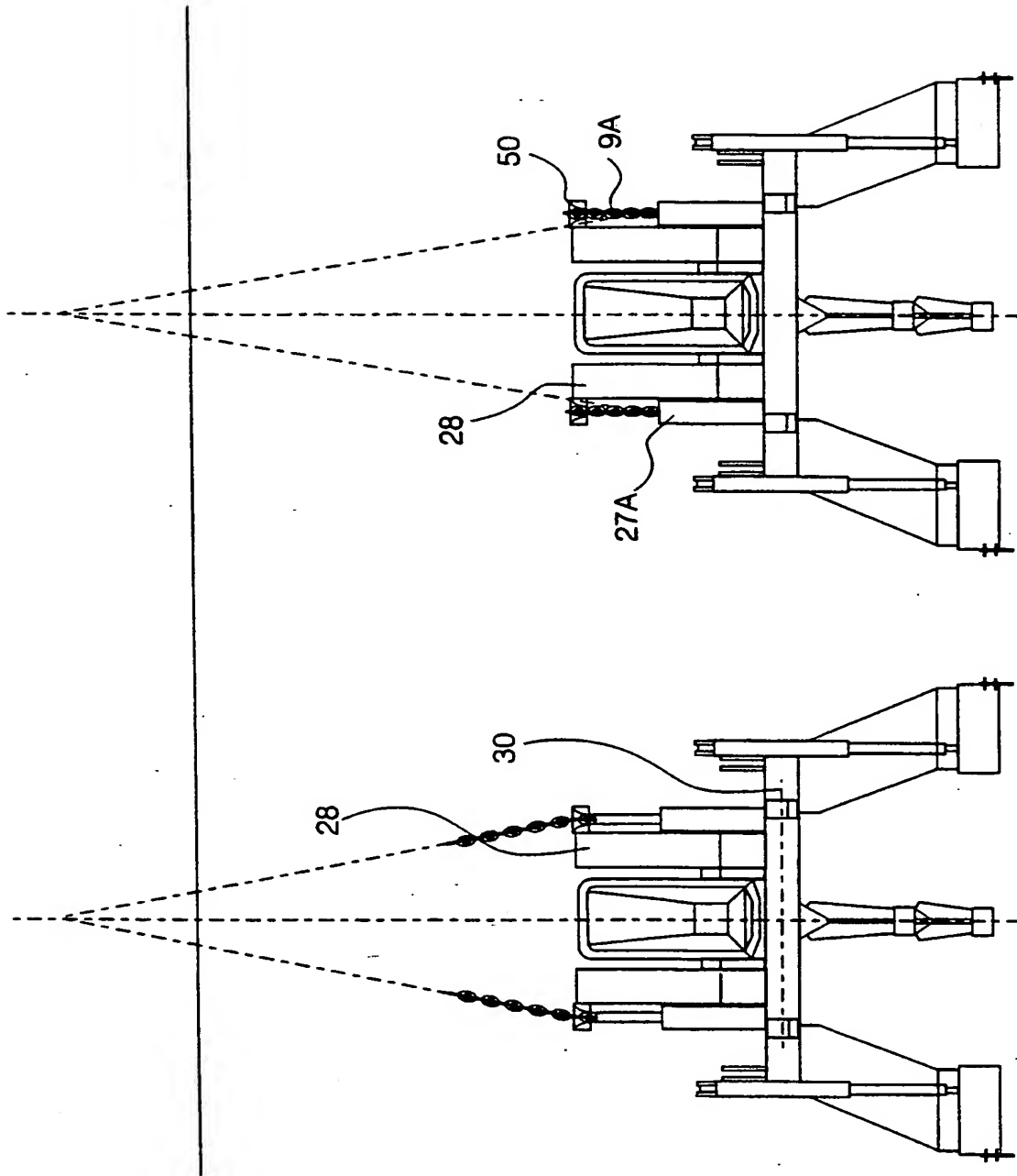


Fig. 11

Fig. 10

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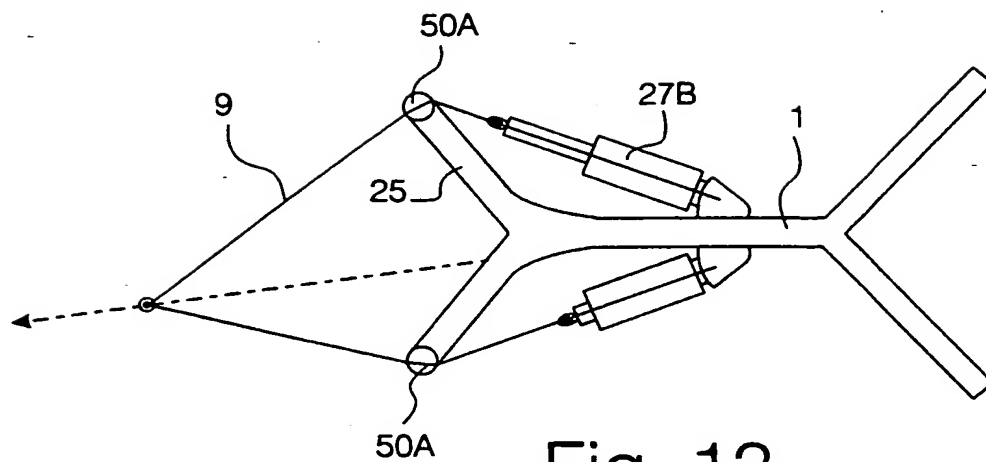


Fig. 12

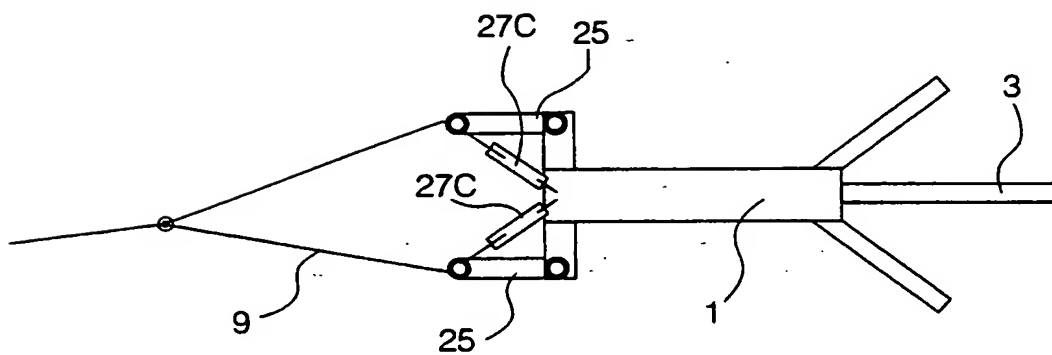


Fig. 13



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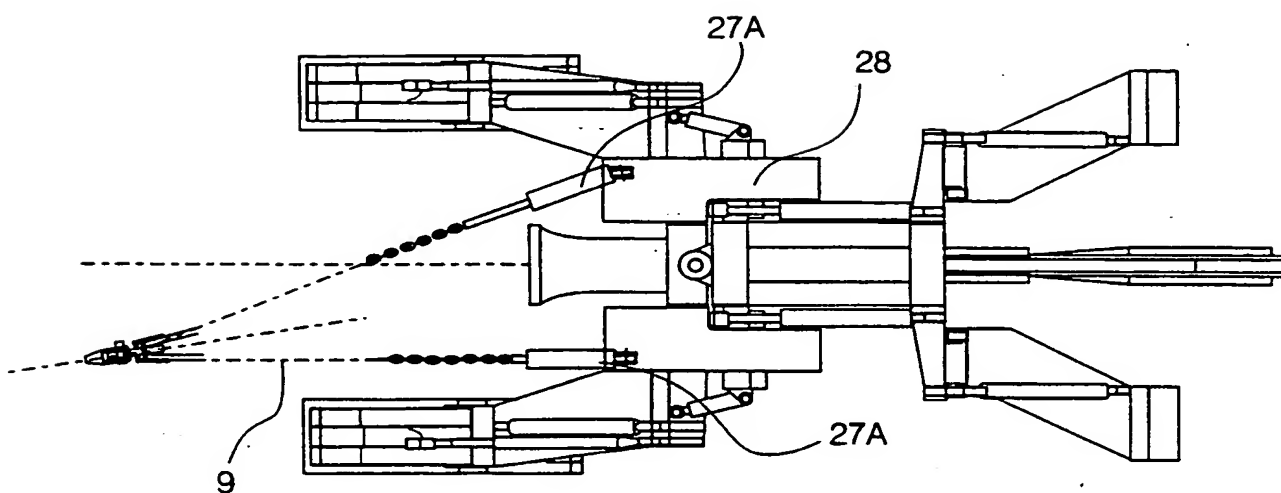


Fig. 14

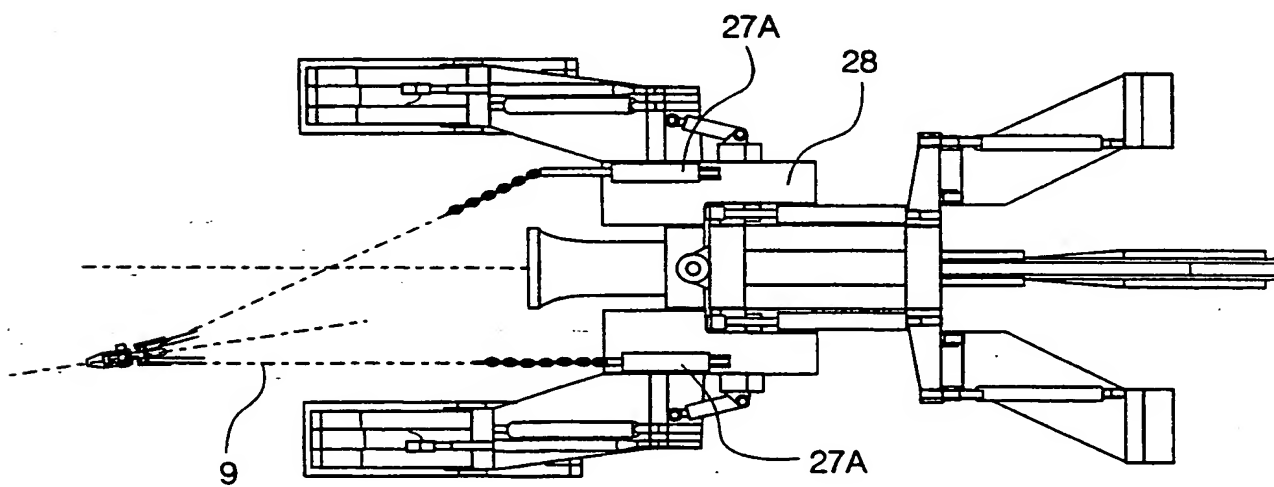


Fig. 15

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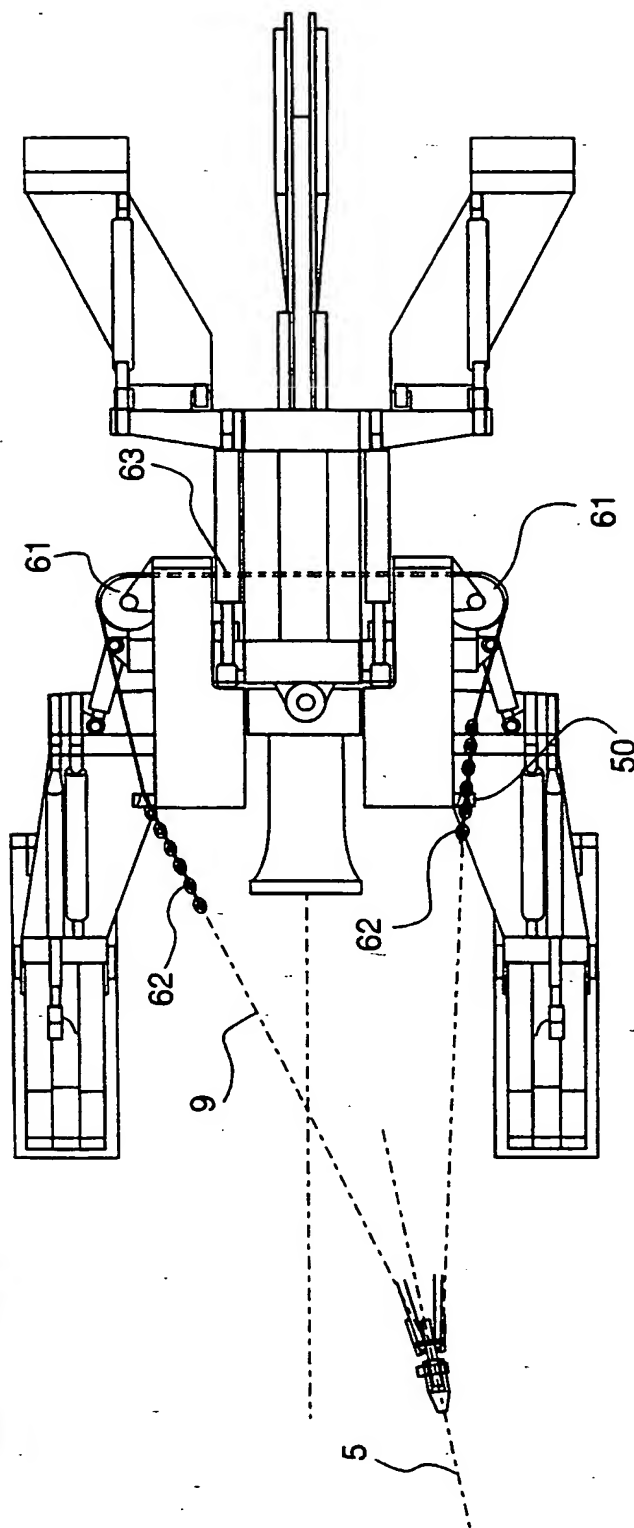


Fig. 16

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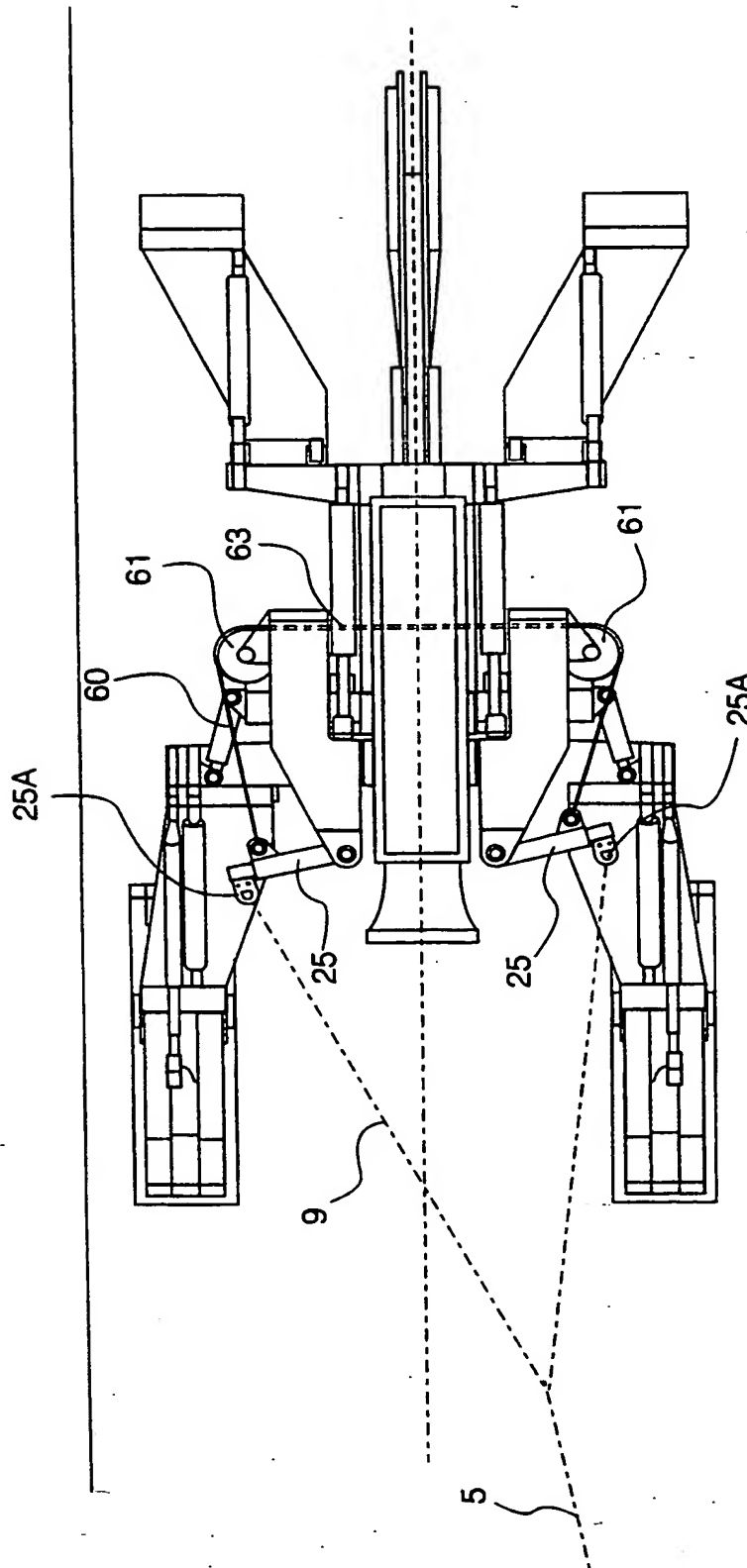


Fig. 17

# INTERNATIONAL SEARCH REPORT

Intern. Application No

PCT/GB 00/03615

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 E02F5/10 E02F5/14

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E02F H02G F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 759 138 A (GRINSTED TIMOTHY W) 26 July 1988 (1988-07-26)	16, 17
Y	figures 5, 6, 8	1, 3-6, 8, 9, 12, 13
A	figures 3, 4	2, 11, 14, 15
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

1 December 2000

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

Intern. Application No

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A	figures 1,2,6-8  column 2, line 36 - line 58 ----	1-7,9, 14,15
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A	GB 2 285 821 A (SOIL MACHINE DYNAMICS LTD) 26 July 1995 (1995-07-26) ----	
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